

Private Pilot Flight Lesson: Four Fundamentals

Objectives:

1. Understand the flight controls (ailerons, elevator, rudder) and their aerodynamic principles.
2. Understand the *use* of the flight controls and trim to control the aircraft.
3. Recognize what the airplane is doing by referencing the nose's appearance on the horizon (the attitude).
4. Ability to transition from straight-and-level flight to a climb, descent, and turns (and visa versa).

Justification:

1. Understanding of the principles and use of the flight controls are necessary for all maneuvers required to fly an airplane.
2. Flight, at any time is a combination of the four fundamentals.
3. Using trim will greatly increase the accuracy of one's aircraft control, and decrease one's active workload.

Schedule:

Activity	Est. Time
Ground	1.25
Preflight/Taxi	0.25
Flight	1.0
Debrief	0.25
Total	2.75

Elements Ground:

- four forces
- how an airplane flies
- axes and flight controls
- attitude (optional)

Recommended Readings:

PHAK	Chapter 1, 2, 3
AFH	Chapter 3: 3-1 to 3-7

Elements Air:

- Four Fundamentals
 - straight-and-level
 - transitions to climbs
 - transitions to descents
 - transitions to turns
- Trim tabs

Completion Standards:

1. When the student is able to transition between the four fundamentals using nose referencing on the horizon for attitude orientation, with minimal assistance from the instructor
2. when the student is able to use the trim tabs effectively with minimal assistance from the instructor.

Common Errors:

- fixates on instruments
- makes large control corrections
- does not trim aircraft

Presentation Ground:

Four Forces

1. There are four forces that act upon an airplane at all times
 - (1) lift :the aerodynamic force that is created by air moving over an airfoil.
 - (2) drag :the force opposing the motion of an aircraft as it moves through the air
 - (3) thrust :the forward pulling (or pushing) force developed by an aircraft engine.
 - (4) weight :the downward force of an aircraft due to gravity.

How and airplane flies

1. An airplane flies because of lift.
 - i. lift offsets weight and allows a plane to fly.
 - (2) airfoil :any member or surface of an aircraft whose major function is a dynamic interaction with the airflow to accomplish a specific purpose.
2. an airplane has four airfoils
 - (1) wing
 - i. :the major lift-producing structure of an airplane.
 - ii. governed by two scientific laws
 - (i) Newton's Third Law of Motion :For every action there is an equal and opposite reaction.
 - a. The wing's position creates a downward deflection of the air, creating an upward force on the wings and thus the aircraft.
 - b. This accounts for approximately 66% of the lift produced by the wing.
 - (ii) Bernoulli's principal :As air velocity increases, the pressure decreases, and as air velocity decreases, the pressure increases.
 - (iii) hose example
 - (iv) this accounts for approximately 33% of the lift produced by the wing.
 - (v) Definitions
 - a. chord line :A straight line drawn directly from the leading edge to the trailing edge of the wing
 - b. relative wind :The direction of airflow parallel and opposite to the flight path of the aircraft
 - c. Angle of Attack (AoA) :The acute angle measured between the chord line of an airfoil and the relative wind.
 - (2) propeller
 - i. The propeller creates lift in the forward direction. This is defined as thrust
 - ii. The thus created by the propeller allows the air to flow over the wing, thus creating lift.
 - (3) horizontal stabilizer
 - i. balances the lift produced by the wing with "negative lift" or down force. This is due to the location of the CG with relation to the center of lift.
 - (4) vertical stabilizer
 - i. keeps the plane pointed in the direction of flight
 - (5) As Pilots, we just manage the four forces with the controls and the throttle
3. axes and flight controls

- (1) There are three axes and three flight controls to control the stability about each of the axes.
- i. lateral axis
 - (i) movement about it is called pitch
 - (ii) pitch is controlled by the elevator
 - ii. vertical axis
 - (i) movement about it is called yaw
 - (ii) yaw is controlled by the rudder
 - iii. longitudinal axis
 - (i) movement about it is called roll
 - (ii) roll is controlled by the ailerons
- (2) how do these control the aircraft?
- i. elevator
 - (i) *:hinged control surface attached to the horizontal stabilizer used to move the airplane about its lateral axis*
 - (ii) *elevator is controlled by the forward and backward movement of the yoke*
 - (iii) by changing the position of the elevator, you change the lift produced by the horizontal stabilizer
 - a. this is achieved by changing the airfoil of the stabilizer and increasing deflection.
 - (iv) the nose moves up because the tail moves down, and visa versa.
 - ii. rudder
 - (i) *:the primary control surface that controls yaw, the movement of the airplane about its vertical axis*
 - (ii) the rudder is controlled by the foot pedals
 - (iii) acts similar to the elevator by in a different plane
 - (iv) the rudder does not turn the airplane...it's the horizontal component of lift that does.
 - (v) the nose moves left because the tail moves right, and visa versa
 - iii. ailerons
 - (i) *:primary aerodynamic control surfaces usually located on the outboard trailing edge of the wing, hinged to move up and down, producing a rolling moment about the airplane's longitudinal axis.*
 - (ii) ailerons are controlled by the left and right movement of the yoke.
 - (iii) ailerons move opposite each other. one goes up, the other goes down.
 - (iv) an aileron that is lowered produces more lift. one that is raised produces less lift.
- (3) trim tabs (optional)
- i. *:secondary flight controls located on the primary flight controls that, when displaced, reposition the primary flight control surfaces.*
 - ii. elevator trim is controlled by the trim wheel.
 - (i) roll wheel down, holds plane nose up, and visa versa
 - iii. rudder trim may be controlled via a trim wheel, or a bendable surface that is adjusted before flight
 - iv. purpose of trim tabs is to hold the primary control surface in the deflected position aerodynamically instead of through control pressure.

- v. changes in airspeed, power, or flap position may affect trim.
- vi. when adjusting trim, don't fly with trim...fly with control pressure, and once in the desired position "trim away the pressure"

4. **attitude** (optional)

- (1) *:position of the aircraft's axes in relation to the horizon*
- (2) explain the use of nose referencing on the horizon to attain desired attitudes
 - i. nose 8" below horizon: level (C172)
 - ii. nose tangent to the horizon: climb (C172)
 - iii. nose more than 8" below the horizon: descent (C172)
 - iv. This also applies when in a bank.

Presentation Air:

1. Four fundamentals

- (1) fly straight-and-level
 - i. note nose reference to the horizon
- (2) transition from straight and level to a climb
 - i. use nose referencing to commence, continue, and complete the climb
 - (i) pitch - climb attitude
 - (ii) power - full
 - (iii) trim - to hold climb attitude
- (3) transition from straight-and-level to a descent
 - i. use nose referencing to commence, continue, and complete the descent
 - (i) power - 2100 RPM
 - (ii) pitch - should settle on its own
 - (iii) trim - should not need to change
- (4) transition from straight-and-level to a turn (right and left)
 - i. use nose referencing to commence, continue, and complete the turn.
 - (i) yoke/aileron in direction of turn
 - (ii) as bank angle increases, back pressure increases
 - (iii) at desired bank, neutralize aileron, but hold "back elevator"
 - (iv) to stop turn, opposite aileron and release back elevator as bank angle decreases
 - ii. don't forget rudder usage
 - (i) left turn requires left rudder
 - (ii) right turn requires right rudder
 - (iii) "step on the ball"
- (5) why trim sometimes but not others?
 - i. trim is a function of speed, or what position the elevator is in.
 - ii. AoA is determined by the down force produced by the tail.
 - iii. higher AoA means slower speed, and visa versa
 - iv. change in speed = change in elevator = change in trim
 - v. (show examples)
 - (i) transition to climb
 - (ii) transition to descent